2000. The Journal of Arachnology 28:217–222

SPIDERS IN ROCKY HABITATS IN CENTRAL BOHEMIA

Vlastimil Růžička: Institute of Entomology, Czech Academy of Sciences, Branišovská 31, 370 05 České Budějovice, Czech Republic

ABSTRACT. Spiders of andezite and limestone rocks in Central Bohemia were studied. The material was collected using hanging desk traps. Rocky habitats are inhabited by a well-established spider assemblage. A lower slope angle, and consequently more diverse terrain, probably support a higher species diversity. Some species inhabit exclusively rocky habitats. *Segestria bavarica* and *Theridion betteni* occur in the Czech Republic exclusively on rocky habitats. *Erigonoplus jarmilae*, *Zelotes puritanus*, and *Altella biuncata* appear to occur primarily on rocky habitats. *Anyphaena furva* appears to live on trunks of trees growing on sun-exposed rocks. Some thermophilous species narrow their ecological niche exclusively to southern exposed rocky habitats with a warm microclimate towards the north.

Keywords: Spiders, rocks, vegetation-free habitats, thermophilous species

The lowlands of Central Europe were originally covered mostly with closed forests, although isolated islet-like natural non-forest habitats occasionally occurred. Today the surface of some of these non-forested areas is composed of bare bedrock or products of its erosional breakdown (without a soil layer) and are typified by gravel and sand banks, sand dunes, scree slopes and rock outcrops. According to their specific substratum and microclimate, these habitats can harbor specialized spider species.

There has been no comprehensive study of the spiders of gravel banks in the Czech Republic. However, useful data were obtained during the grid mapping of lycosid distribution by Buchar (1995); and gravel and sand banks are known to harbor several specific inhabitants. Of these, *Oedothorax agrestis* (Blackwall 1853) is the most common, *Pardosa morosa* (L. Koch 1870) occurs sporadically, while *Arctosa cinerea* (Fabricius 1777) and *Arctosa maculata* (Hahn 1822) are very rare.

There is also a need for a detailed study of the spiders of sand dunes in the Czech Republic. However, the specific arachnofauna of this habitat is known. *Arctosa perita* (Latreille 1799), *Steatoda albomaculata* (De Geer 1778), and *Attulus saltator* (Simon 1868) represent specialized inhabitants of sand dunes (Miller 1971; Buchar 1995). New investigations of sand dunes in southern Moravia have resulted in several new records for the Czech Republic (Růžička 1998): *Uloborus walckenaerius* Latreille 1806, *Mecynargus foveatus* (Dahl 1912) and *Titanoeca psammophila* Wunderlich 1993.

Scree slopes have been intensively studied over the past years, and microclimate conditions and spider assemblages have been described (Růžička & Zacharda 1994; Růžička et al. 1995). *Acantholycosa norvegica sudetica* (L. Koch 1875), *Bathyphantes simillimus buchari* Růžička 1988, *Lepthyphantes improbulus* Simon 1929 and *Wubanoides uralensis* (Pakhorukov 1981) are the most specific inhabitants of boulder accumulations in the Czech Republic (Růžička 1996; Růžička & Hajer 1996; Růžička & Zacharda 1994).

Rock faces, rock walls, solitary rock outcrops and rocky slopes in deeply-cut river valleys remain some of the most inaccessible and unknown habitats. Due to the difficulty of exploiting them economically, these habitats have remained unchanged over the entire Holocene. The plant and animal communities inhabiting them represent edaphic climaxes. The aim of this study was to describe and evaluate the species composition of a spider assemblage in two different rocky habitats in the warmest territory in Central Bohemia.

METHODS

Study sites.—Both localities studied lie in Central Bohemia, on the border of Thermophyticum and Mesophyticum, and both are at similar elevations with similar exposures. Nezabudické Skály (rocks) Nature Reserve is

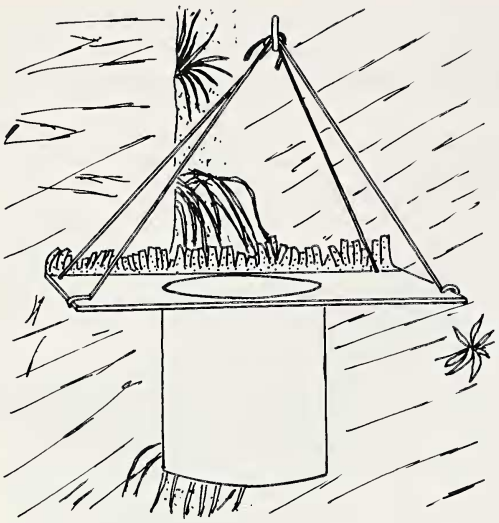

Figure 1.—Traps, as shown above, hanging against the creviced and rough rock surfaces, were used to capture the spiders. They contained a mixture of formaldehyde and glycerol.

situated in the Křivoklátsko Biosphere Reserve, near Nezabudice village, about 50 km west of Prague, elevation 290 m. The rocks are composed of andezite and form a southeasterly exposed amphitheater. The western part of this amphitheater is formed by bare rocks, small scree fields and narrow scree ledges with plant tussocks, shrubs and solitary trees. The rocky slope is about 60 m high with a slope angle of about 45°.

Kotýz National Nature Monument is situated in the Bohemian Karst Protected Landscape Area, near Koněprusy village, about 30 km southeast of Prague, elevation 380 m. The vertical southern exposed rock wall is made of limestone. It is about 40 m high and is partly overgrown by plant tussocks.

We automated the collecting of spiders on rocks using hanging desk traps (Růžička & Antuš 1997) (Fig. 1). The traps, made of rigid plastic, consist of a desk (25 × 20 cm, which formed an artificial horizontal surface) and a can (13 cm high and 10.5 cm in diameter) inserted in the center of the desk. The traps contained a mixture of 7% formaldehyde and 10% glycerol with a few drops of a surfactant. Each trap was hung from a hooked nail. A band of emery tape was stuck on the back edge of the trap and shaped to form a connection, or transit, between the desk and the rock surface. We hung the traps in marginal, creviced, and rough parts of the rocks in the mosaic of bare rock surface and vegetation tussocks. Six traps were placed in Nezabudické Skály from May 1996 to April 1997, and in Kotýz from May to October 1996. Five additional desk traps with a half-circle back margin were hung on old oaks growing at Nezabudické Skály from April to June 1997.

The material was evaluated with respect to the occurrence of the species in phytogeographical regions and in habitats of various degree of originality (Buchar 1993) (see legend of Table 1). The nomenclature follows the check list of spiders of the Czech Republic (Buchar et al. 1995).

RESULTS AND DISCUSSION

Species diversity.—A total of 218 determinable spider individuals belonging to 48 species was collected on rocks at Nezabudické Skály. A total of 102 determinable spider individuals belonging to 27 species was collected at Kotýz. A total of 30 spider individuals belonging to 10 species was collected on tree trunks at Nezabudické Skály (Table 1).

Fourteen common species and a common dominant species, *Drassodes lapidosus,* reflect the similarity of both sites. The localities studied differ in the type of rock and in the slope angle. The higher number of species and individuals at Nezabudické Skály is probably caused by a greater diversity of terrain conditions resulting in more niche diversity. Lower slope angle allows the occurrence of small scree fields, small ledges, and consequently rich plant tussocks, solitary shrubs and trees.

The frequency of specimens of species occurring primarily in natural habitats amounts to 0.41 at Nezabudické Skály, and 0.45 at Kotýz, which is considerably higher than the minimal value of 0.20 that is characteristic for protected regions in the Czech Republic (Růžička 1987). High frequency of these species indicates original habitats.

Rock as a habitat.—Hänggi et al. (1995) distinguish 85 habitat types in their classification of Central European habitats. They include only the habitat "Alpine rocks" in the category of "Alpine habitats." The rocks of lower elevations are omitted. However, there are spider species that live occasionally, primarily, or exclusively on rocks. Heimer & Nentwig (1991) and also Miller (1971) described rocks as living habitat for about 20

Table 1.—Survey of material collected (♂/♀/j) by hanging desk traps on rocks at Nezabudické Skály (A), on tree trunks at Nezabudické Skály (B), and on rocks at Kotýz (C). T = occurring primarily in Thermophyticum, M = in Mesophyticum, O = in Oreophyticum, N = non-specific; 1 = occurring in natural habitats corresponding to climatic or edaphic climax, 2 = capable of occupying some shadow and wet secondary, semi-natural habitats (cultural forests, shrubs, cultivated wetlands), 3 = capable of forming viable populations in artificially deforested, man-made habitats (fields, meadows, urban habitats).

			A	B	C
Segestriidae					
T	1	*Segestria bavarica* C. L. Koch 1843	3/–	–	–/1/1
Dysderidae					
N	2	*Harpactea hombergi* (Scopoli 1763)	1/–	1/9	1/–
Eresidae					
T	1	*Eresus cinnaberinus* (Olivier 1789)	–	–	2/–
Theridiidae					
T	1	*Dipoena melanogaster* (C. L. Koch 1837)	–	–	1/1
?	1	*Dipoena nigroreticulata* (Simon 1879)	–/1	–	–
N	2	*Episinus truncatus* Latreille 1809	–	–	–/1
T	1	*Theridion betteni* Wiehle 1960	–/1	–	–
N	2	*Theridion tinctum* (Walckenaer 1802)	–	1/–	–
Linyphiidae					
N	3	*Araeoncus humilis* (Blackwall 1841)	–/1	–	–
N	2	*Bathyphantes nigrinus* (Westring 1851)	–/1	–	–
O	2	*Centromerus sellarius* (Simon 1884)	1/1	–	–
N	3	*Centromerus sylvaticus* (Blackwall 1841)	1/–	–	–
N	3	*Dicymbium nigrum* (Blackwall 1834)	2/1	–	–
T	1	*Erigonoplus jarmilae* (Miller 1943)	15/5	–	–
N	2	*Lepthyphantes flavipes* (Blackwall 1854)	2/–	–/1	–
T	1	*Lepthyphantes keyserlingi* (Ausserer 1867)	2/–	–	2/–
N	3	*Lepthyphantes mengei* Kulczyński 1887	1/–	–	–
N	2	*Lepthyphantes pallidus* (O. P.-Cambridge 1871)	–/1	–	–
N	3	*Linyphia triangularis* (Clerck 1757)	–/1	–	–
N	3	*Micrargus subaequalis* (Westring 1851)	–	–	1/–
N	2	*Microneta viaria* (Blackwall 1841)	2/–	–	–
N	1	*Panamomops affinis* Miller & Kratochvíl 1939	1/–	–	–
Tetragnathidae					
N	3	*Pachygnatha degeeri* Sundevall 1830	–	–	1/–
Araneidae					
T	1	*Gibbaranea bituberculata* (Walckenaer 1802)	–	1/–	–
N	3	*Mangora acalypha* (Walckenaer 1802)	–/–/2	–	–/1
Lycosidae					
T	2	*Alopecosa accentuata* (Latreille 1817)	5/1	–	–
T	1	*Arctosa figurata* (Simon 1876)	–	–	1/–
?	1	*Pardosa alacris* (C. L. Koch 1833)	2/2	–	5/3
T	1	*Pardosa bifasciata* (C. L. Koch 1834)	–	–	3/3
T	1	*Trochosa robusta* (Simon 1876)	1/1	–	–
M	3	*Trochosa ruricola* (De Geer 1778)	6/1	–	–
N	2	*Xerolycosa nemoralis* (Westring, 1861)	6/–	–	4/–
Agelenidae					
O	2	*Histopona torpida* (C. L. Koch 1834)	2/–	–	–
N	2	*Textrix denticulata* (Olivier 1789)	6/–/1	–	–

Table 1.—Continued.

			A	B	C
Dictynidae					
T	1	*Altella biuncata* (Miller 1949)	5/–	–	–
Amaurobiidae					
O	2	*Callobius claustrarius* (Hahn 1833)	1/–	–	–
O	2	*Coelotes inermis* (L. Koch 1855)	4/–	–	–
N	2	*Coelotes terrestris* (Wider, 1834)	1/–	–	–
Titanoecidae					
T	1	*Titanoeca quadriguttata* (Hahn 1833)	1/–	–	7/2
Anyphaenidae					
M	1	*Anyphaena furva* Miller 1967	–	3/–	–
Liocranidae					
N	2	*Apostenus fuscus* Westring 1851	1/–	–	–
N	3	*Liocranum rupicola* (Walckenaer 1830)	–	1/–	–/–/2
N	2	*Phrurolithus festivus* (C. L. Koch 1835)	–	–	1/–
Clubionidae					
N	1	*Clubiona comta* C. L. Koch 1839	–	1/2	–
Zodariidae					
T	1	*Zodarion germanicum* (C. L. Koch 1837)	1/1	–	–
Gnaphosidae					
T	1	*Callilepis schuszteri* (Herman 1879)	2/3	–	–
N	2	*Drassodes lapidosus* (Walckenaer 1802)	34/4	6/2	37/4
T	1	*Drassyllus villicus* (Thorell 1875)	1/1	–	–
N	1	*Echemus angustifrons* (Westring 1862)	1/–	–	–
T	1	*Gnaphosa opaca* Herman 1879	5/1	–	–
T	1	*Zelotes erebeus* (Thorell 1870)	2/1	1/–	–
?	1	*Zelotes exiguus* (Müller & Schenkel 1895)	5/3	–	–
T	1	*Zelotes puritanus* Chamberlin, 1922	7/4	–	–
Thomisidae					
M	1	*Ozyptila blackwalli* Simon, 1875	–	–	1/–
T	1	*Ozyptila nigrita* (Thorell 1875)	2/–	–	–
M	3	*Xysticus kochi* Thorell 1872	6/3	–	1/–
T	1	*Xysticus ninnii* Thorell 1872	–	–	3/–
Salticidae					
T	2	*Aelurillus v-insignitus* (Clerck 1757)	14/3/2	1/–	–
?	1	*Heliophanus aeneus* (Hahn 1831)	6/–	–	–
T	2	*Heliophanus cupreus* (Walckenaer 1802)	1/–	–	1/–
T	1	*Pellenes tripunctatus* (Walckenaer 1802)	–	–	1/–
T	1	*Philaeus chrysops* (Poda 1761)	3/–	–	6/–
T	1	*Phlegra festiva* (C. L. Koch 1834)	–	–	1/–
N	3	*Salticus scenicus* (Clerck 1757)	2/2/1	–	1/–
T	1	*Sitticus penicillatus* (Simon 1875)	–	–	–/1
M	3	*Sitticus pubescens* (Fabricius 1775)	2/2	–	1/–

spider species. Růžička (1992) described the spider assemblage inhabiting sandstone rocks in northern and northeastern Bohemia. *Bathyphantes simillimus* inhabits, exclusively, these sandstone rocks in Central Europe, *Lepthyphantes pulcher* inhabits not only sandstone, but also granite and limestone rocks.

Drassodes lapidosus was the dominant species in both localities studied; this species is generally considered to live under stones. The

occurrence of *Segestria bavarica*, *Theridion betteni*, *Textrix denticulata*, and *Salticus scenicus* on rocks is mentioned by Miller (1971). The first two species occur exclusively on rocks in the Czech Republic. Abundant occurrence of *Titanoeca quadriguttata*, *Callilepis schuszteri*, *Gnaphosa opaca*, *Zelotes exiguus*, and *Aelurilus v-insignitus* at localities studied indicates that these species are well able to colonize rocky habitats. The abundance of *Erigonoplus jarmilae*, *Zelotes puritanus*, and *Altella biuncata* at Nezabudické Skály indicates that they occur primarily on rocky habitats. During intensive research of xerotherm localities in the Czech Republic, six specimens of *Zelotes puritanus* were collected at forest steppes (Miller & Buchar 1977; Šinková 1973). Šmaha (1983) collected 12 specimens at steppe slopes with isolated rocks in Křivoklátsko Biosphere Reserve, while we obtained 11 specimens; 14 specimens of *Erigonoplus jarmilae* were collected at rock steppes (Miller 1947; Valešová 1962), we obtained 20 specimens; 5 specimens of *Altella biuncata* were collected on rock steppes and rocky slopes (Miller 1949; Buchar 1989; Dolanský 1997), we obtained 5 specimens.

The occurrence of *Zelotes puritanus* (= *Zelotes kodaensis* Miller & Buchar 1977) in Europe is known in the Czech Republic, Poland (Staręga 1972) and Austria (Thaler 1981). This species inhabits exclusively original habitats, rocks and rock steppes here. This species cannot represent a recent introduction into Europe (Platnick & Shadab 1983). In North America *Zelotes puritanus* inhabits a wider range of habitats. Specimens have been collected in pitfall traps in aspen, fir, scrub oak, lodgepole, ponderosa pine, black spruce forests, in beach litter, meadows, pastures, prairies, sagebrush, and under logs and rocks.

Anyphaena furva was described by Miller (1967) from one male collected on a rock wall in the Zádielská Dolina valley, Slovakia. Šmaha (1985) collected one male in a scree field under Týřovská Skála rock in Křivoklátsko Reserve. Our finding of three males on tree trunks at Nezabudické Skály coincides to the biology of the closely related *Anyphaena accentuata* (Walckenaer 1802), and suggests that *Anyphaena furva* inhabits tree trunks on sun-exposed rocks and can occasionally move onto such rocks.

Rock as a habitat of thermophilous species.—The frequency of specimens of thermophilous species amounts 43% at Nezabudické Skály, and 38% at Kotýz. Together, 26 thermophilous species belonging to 11 families were recorded.

The surface of sand dunes and scree slopes can be heated to high temperatures. This effect is caused by isolating air interlayers. The specificity of arachnofauna of sand dunes is well known. In contrast, we found no specific inhabitants of upper overheated margins of boulder accumulations. This is probably the result of the very low humidity of these sites (Růžička et al. 1995). Rocks are the third bare, natural habitat, which can also overheat.

Potential surface temperature and heat accumulation capacity are considered as the most important characteristics of thermal behavior of rocks. Different values of physical constants of particular rocks actually suggest that the rocky substratum may play a decisive role in the thermal balance of habitats dominated by larger exposed rock. Both andezite and limestone are considered to be "warm, calorific" rock with a predisposition to harboring isolated populations of thermophilous plant and animal species (Rejmánek 1971).

Thermophilous *Segestria bavarica* inhabits rocky habitats (in Switzerland and Austria), and also forests, where it was collected in pitfall traps and by hand-picking under bark (Noflatscher 1991; Maurer & Hänggi 1990). In the Czech Republic, it occurs exclusively on rocks. This case supports a hypothesis that, in some northern locations, thermophilous species narrow their ecological niche exclusively to south-exposed rocky habitats, and they can reach the northernmost range of their distribution in these habitats. For example, Jonsson (1995) recorded the most northern occurrence of several thermophilous species in Sweden on rocky habitats.

ACKNOWLEDGMENTS

I thank Petr Antuš for his help with collecting spiders on rocks, and Prof. Jan Buchar for his constructive criticism of the manuscript. This research was supported by the Grant Agency of the Czech Republic (Project No. 206/96/0326 and 206/99/0673).

LITERATURE CITED

Buchar, J. 1989. The knowledge of the present Bohemian arachnofauna and its improvement to

evaluation of natural conditions. Thesis, Charles University, Praha. 206 pp. (in Czech).

Buchar, J. 1993. Kommentierte Artenliste der Spinnen Böhmens (Araneida). Acta Univ. Carolinae Biol., 36 [1992]:383–428.

Buchar, J. 1995. Bohemian wolf spiders (Araneida: Lycosidae). Acta Univ. Carolinae Biol., 39:3–28.

Buchar, J., V. Růžička & A. Kůrka. 1995. Check list of spiders of the Czech Republic. Pp. 35–53, *In* Proc. 15th European Colloquium of Arachnology. (V. Růžička, ed.). Institute of Entomology, České Budějovice.

Dolanský, J. 1997. Thermophilous community of spiders from east-west part of Železné Hory Mts. Vč. sb. přír. Práce a studie, 5:121–126 (in Czech, English summary).

Hänggi, A., E. Stöckli & W. Nentwig. 1995. Lebensräume mitteleuropäischer Spinnen. Centre suisse de cartographie de la faune, Neuchâtel. 460 pp.

Heimer, S. & W. Nentwig. 1991. Spinnen Mitteleuropas. Paul Parey. Berlin and Hamburg. 543 pp.

Jonsson, L.J. 1995. *Cheiracanthium elegans*, a new spider to Northern Europe, with a brief summary of the genus in Sweden. Entomol. Tidskr., 116: 55–58.

Maurer, R. & A. Hänggi. 1990. Katalog der schweizerischen Spinnen. Sweizerischer Bund für Naturschutz. 411 pp.

Miller, F. 1947. Spiders of the serpentine rocky steppes near Mohelno. Acta Soc. pro cognitione et conservatione naturae in Moraviae Silesiaque, 7:1–128 (in Czech, French summary).

Miller, F. 1949. The new spiders from the serpentine rocky heath near Mohelno (Moravia occ.). Entomol. Listy, 12:88–98.

Miller, F. 1967. Studien über die Kopulationsorgane der Spinnengattung *Zelotes*, *Micaria*, *Robertus* und *Dipoena* nebst Beschreibung einiger neuer oder unvollkommen bekannter Spinnenarten. Acta Sc. Nat. Brno, 1(7):251–298.

Miller, F. 1971. Order Spiders Araneida. Pp. 51–306, *In* Key to the Fauna of the Czechoslovakia IV. (M. Daniel & V. Černý, eds.). ČSAV, Praha (in Czech).

Miller, F. & J. Buchar. 1977. Neue Spinnenarten aus der Gattung *Zelotes* Gistel und *Haplodrassus* Chamberlin (Araneae, Gnaphosidae). Acta Univ. Carolinae Biol., 1974:157–171.

Noflatscher, M.-T. 1991. Beiträge zur Spinnenfauna Südtirols. III: Epigäische Spinnen an Xerotherm-Standorten am Mitterberg, bei Neustift und Sterzing (Arachnida: Aranei). Ber. nat.-med. Verein Innsbruck, 78:79–92.

Platnick, N.I. & M.U. Shadab. 1983. A revision of the American spiders of the genus *Zelotes* (Araneae, Gnaphosidae). Bull. American Mus. Nat. Hist., 174:97–192.

Rejmánek, M. 1971. Ecological meaning of the thermal behaviour of rocks. Flora, 160:527–561.

Růžička, V. 1987. Biodiagnostic evaluation of epigeic spider communities. Ecology (CSSR), 6: 345–357.

Růžička, V. 1992. Current results of an arachnological survey of some sandstone rock sites in Bohemia (so-called "rock cities"). Arachnol. Mitt., 3:1–13.

Růžička, V. 1996. Species composition and site distribution of spiders (Araneae) in a gneiss massif in the Dyje river valley. Rev. Suisse de Zool., vol. hors série, pp. 561–569.

Růžička, V. (ed.). 1998. Spiders of southeastern Moravia. Sborník Přírodovědného klubu v Uh. Hradišti 3:23–35 (in Czech, English summary).

Růžička, V. & P. Antuš. 1997. Collecting spiders from rocky habitats. Newsl. British Arachnol. Soc., 80:4–5.

Růžička, V. & J. Hajer. 1996. Spiders (Araneae) of stony debris in North Bohemia. Arachnol. Mitt., 12:46–56.

Růžička, V., J. Hajer & M. Zacharda. 1995. Arachnid population patterns in underground cavities of a stony debris field (Araneae, Opiliones, Pseudoscorpionidea, Acari: Prostigmata, Rhagidiidae). Pedobiologia, 39:42–51.

Růžička, V. & M. Zacharda. 1994. Arthropods of stony debris in the Krkonoše Mountains, Czech Republic. Arctic and Alpine Res., 26:332–338.

Šinková, H. 1973. Spiders of the hills Šance and Hradiště at Závist near Zbraslav. BSc thesis, Charles University, Praha. 67 pp. (in Czech).

Šmaha, J. 1983. Beitrag zur Erkenntnis der Arachnofauna einiger Biozönosen des Køivoklát-Gebietes (Mittelböhmen). Vřst. čs. Společ. zool., 47:126–136.

Šmaha, J. 1985. Einige Ergebnisse der Arachnofaunaforschung im Staatlichen Schutzgebiet Týřov. Bohem. cent., 14:189–224 (in Czech, German summary).

Straręga, W. 1972. Für die Fauna Polens neue und seltenere Spinnenarten (Aranei), nebst Beschreibung von *Lepthyphantes milleri* sp. n. Fragmenta Faun., 18:55–98 (in Polish, German summary).

Thaler, K. 1981. Bemerkenswerte Spinnenfunde in Nordtirol (Österreich) (Arachnida: Aranei). Veröffentl. Mus. Ferdinandeum, 61:105–150.

Valešová, E. 1962. Spiders of the steppe locality Lochkov-Radotín. BSc thesis, Charles Univerity, Praha, 128 pp. (in Czech).

Manuscript received 6 May 1998, revised 24 September 1999.